

Susan Smith, a Local Emergency Planning Committee (LEPC) member in River City, has completed an initial screening of the toxic hazard posed to her community by the local water treatment plant. She is now ready to use ALOHA to make a more detailed

assessment of the possible effects of the accidental chlorine releases that she has identified as most probable. She especially wants to get an idea of the concentrations of chlorine to which people might be exposed at two locations of special concern: the local hospital, St. Mary's Medical Center, and the Central Valley Elementary School, shown on the map of River City in Figure 1 below.

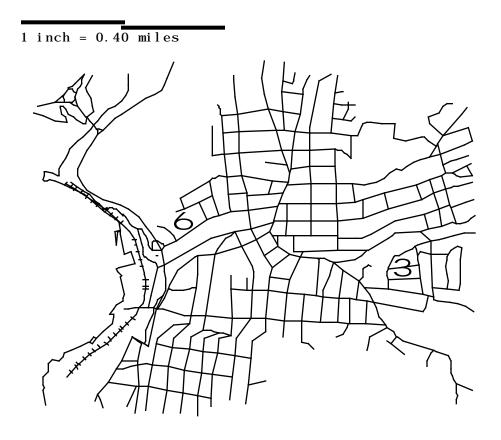


Figure 1. Map of River City. 6 = St. Mary's Medical Center, $3 = Central Valley Elementary School, and <math>\cdot = the River City Water Treatment Plant.$

Susan can obtain some of the information that she needs from ALOHA in the form of Concentration graphs. A Concentration graph is useful whenever you're concerned not only about the extent of the whole area that might be at risk during a particular release (you can see ALOHA's estimate of this area in the Footprint window), but also about the hazard to specific locations, such as schools,

hospitals, nursing homes, or large employment centers. A Concentration graph shows predicted chemical concentrations in both indoor and outdoor air near ground level at any of these locations, during the hour after a chemical release begins.

Before ALOHA can display a Concentration graph for either St. Mary's Medical Center or the Central Valley School, Susan needs to specify the location of the school or hospital. To obtain a good estimate from ALOHA of the potential chlorine concentration in the air within the school or hospital building, she needs to provide ALOHA with some information about the building.

Specifying a location

Susan can choose any of three ways to indicate the location for which she would like to see a Concentration graph:

- First method: double-click in the Footprint window
- Second method: indicate a location on a map
- Third method: enter the location's coordinates directly

First method: The first method is the easiest, but also the least exact. Once Susan has run a release scenario, she can double-click on any point within ALOHA's Footprint window to obtain a Concentration graph for that point. For example, Central Valley Elementary School is located 1 mile directly east of the water treatment plant. Susan runs a release scenario and plots a footprint. She assumes that in this scenario, a west wind would blow the chlorine cloud from the plant directly towards the school. As shown in Figure 2 below, she double-clicks on a point on the footprint centerline one mile downwind of the release point to indicate the school's location relative to the chlorine release point. ALOHA places a crosshair mark on Susan's click point to show that this is the Concentration location, then goes on to display a Concentration graph for the school.

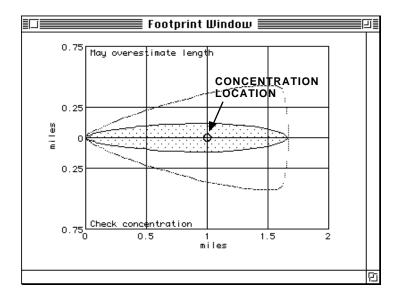


Figure 2. ALOHA's Footprint window. The crosshair mark on the footprint indicates the Concentration location, designated by double-clicking on that point.

The other two methods are more appropriate for planning, because they allow you to specify a location more accurately.

Second method: Once Susan plots an ALOHA footprint on her electronic map of River City in MARPLOT, she can then specify a location on the map for which she would like to see a Concentration graph. To learn how to plot an ALOHA footprint on a map in MARPLOT and indicate a location on the map for which you would like to see a Concentration graph, check Chapter 7 ("Sharing") of the ALOHA user's manual if you're using a Macintosh. If you're using MARPLOTDOS and ALOHA for Windows, check the "Ask Dr. ALOHA" column in the July/August 1993 issue of CAMEO Today for a step-by-step explanation of how to plot a footprint on a map and indicate a Concentration location.

Third method: Susan can choose Concentration... from ALOHA's Display menu, then enter the coordinates of a location. She can describe a location using either fixed (north-south, east-west) or relative (downwind, crosswind) coordinates. (To learn more about entering the coordinates of a location and choosing the type of coordinates to use, choose Concentration..., then click Help.)

An example graph

Figure 3, below, shows a Concentration graph which Susan obtains for St. Mary's Medical Center, a large, enclosed building located one-quarter mile northeast of the water treatment plant. As she prepares this scenario, Susan assumes that a southwest wind blows the chlorine cloud from the plant directly towards the

hospital, so she enters relative coordinates of 1/4 mile downwind and zero miles crosswind into ALOHA. Note that ALOHA predicts the concentrations downwind of a release to be highest along the centerline of a dispersing pollutant cloud (where the crosswind distance is zero), so the centerline concentration will always be the most **conservative** concentration estimate for a location (meaning that by obtaining the centerline concentration, you are less likely to underestimate the potential concentration at a location).

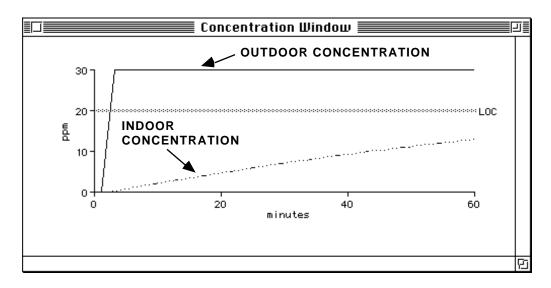


Figure 3. A graph of the predicted indoor and outdoor chlorine concentration at St. Mary's Medical Center, during the hour after an accidental release begins.

In Figure 3, the LOC (Level of Concern) concentration of 20 ppm is shown as a horizontal line that has been drawn on the graph, making it easy to see whether predicted chlorine concentrations reach this important threshold during the hour after the start of a release. (In the upcoming version of ALOHA, LOC lines will automatically appear on Concentration graphs. For now, you can either draw LOC lines by hand on printed Concentration graphs, or copy and paste graphs into a drawing application, then add LOC lines.) The LOC concentration that you choose for a scenario should represent the level above which a hazard may exist. In this case, Susan has chosen to use chlorine's ERPG-2 (Emergency Planning Guideline - Level 2) as her LOC, but many other kinds of LOCs have been established for chlorine. (Check the January/February and March/April 1994 issues of CAMEO Today to learn more about ERPGs and other LOCs.)

You can see predicted chlorine concentrations in both indoor and outdoor air on this graph. You can see from the graph that ALOHA predicts the chlorine concentration outside a building to build up more rapidly than the concentration within the building. This is because ALOHA accounts for the relatively slow rate

at which chlorine gas infiltrates into buildings. To make its indoor concentration computations, ALOHA assumes that all doors and windows on buildings are tightly closed. It expects a pollutant gas to filter into buildings through small openings such as cracks and keyholes. The chlorine concentration within a building with open doors and windows would build up much faster than the indoor concentration shown on the graph above. ALOHA also accounts for building type when it estimates indoor concentration: as we'll discuss below, the indoor concentration line on the graph would look different for a house next door to the medical center.

Building type and indoor air infiltration

Before ALOHA could provide Susan a useful estimate of the pollutant concentration within a building, she first had to describe the type of building she is concerned about (whether it is single- or double-storied or is an enclosed office building), and indicate whether it is relatively sheltered or unsheltered from the wind by trees, buildings, or other obstacles to the wind. ALOHA expects pollutant gas concentrations to build up faster within single-storied than double-storied buildings and within unsheltered than sheltered buildings.

To estimate indoor pollutant concentration, ALOHA first estimates the air exchange rate of a building, the number of times per hour that the volume of air within the building is completely replaced by new outdoor air when doors and windows are closed. This rate is less than 1.0 if it takes more than an hour to completely change the air within the building.

A building type example

To enter building type information for the Central Valley Elementary School, Susan chose **Building Type...** from ALOHA's **SiteData** menu. The school is an unenclosed single-storied building, sheltered from the wind by trees and houses, so she entered the information shown below in Figure 4. Once she entered information about building type and weather conditions, ALOHA was able to compute the building exchange rate; you can see the rate estimate for Central Valley School in Figure 5. For the given weather conditions, ALOHA predicts the number of air changes per hour to be 0.59.

Infiltration Building Parameters	
Select building type or enter exchange parameter	
○ Enclosed office building	Help
Single storied building	
O Double storied building	
○ No. of air changes is 0.59	9 per hour
Select building surroundings	Help
Sheltered surroundings (trees, bushes, etc.)	
○ Unsheltered surroundings	
ОК	Cancel

Figure 4. Building type information for Central Valley Elementary School.

More about building type

Whether you select (a) a single- or double-storied building or (b) an enclosed office building makes a big difference to how ALOHA chooses an exchange rate value. For single-and double-storied buildings, ALOHA accounts for the effects of wind speed and temperature to compute air exchange rates. ALOHA expects a building's air exchange rate to increase if the wind speed increases, because a faster wind exerts more force to push air through the small openings in a building's walls. The degree of difference between indoor and outdoor air temperature also affects ALOHA's air exchange rate estimate (ALOHA assumes the temperature within the building to be 68°F). The greater the temperature difference, the higher the air exchange rate, regardless of whether the air within the building is warmer or cooler than the outside air (this is because air masses of different temperatures have different pressures, and pressure difference stimulates air movement). The higher a building's air exchange rate, the faster the concentration of a toxic gas is predicted to rise within the building. To estimate exchange rate, ALOHA assumes that single- and double-storied buildings are about as leaky as typical North American houses that have been studied by researchers.

In contrast, ALOHA uses a constant air exchange rate of 0.5 for enclosed office buildings, as shown in Figure 5, regardless of wind speed and air temperature. This is because the environment within a large, modern, enclosed building is controlled and kept nearly constant, regardless of weather conditions, using a heating, ventilating, and air-conditioning (HVAC) system. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends that to maintain air quality, air exchange rates for buildings be kept within the range of 0.5 to 1.0 complete changes per hour.

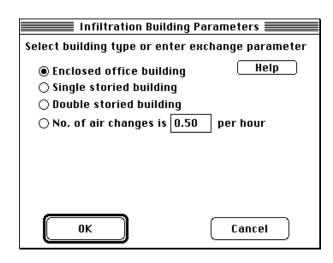


Figure 5. Building type information for an enclosed office building, showing ALOHA's constant air exchange rate value of 0.5. To change this value for a specific building, delete "0.5" from the data field, then type in a new value.

Expect large public buildings or office buildings to have built-in HVAC systems (you can usually easily identify buildings with HVAC systems because their windows can't be opened). When the HVAC system is on, expect the air exchange rate within the building to be higher than if the system is turned off. Therefore, expect pollutant concentrations to rise more rapidly within a building downwind of a release if its system is on than if it is not.

You can obtain the most accurate indoor air concentration predictions for a specific enclosed building from ALOHA by using the building's air exchange rate, rather than relying on ALOHA's generic rate estimate. Check with building managers or owners to learn the air exchange rates for large, enclosed buildings in your community (be sure to ask for the rate at which fresh air from outside is introduced into the building, not the rate at which air is recirculated within the building). If the air exchange rate for a particular building represents the rate while the building is being ventilated, consider this value to be a "worst-case" rate. When possible, try to get an idea of the air exchange rate for the same building when its HVAC system is off (check with the building manager for this information). This rate depends on the "tightness" of the building's construction (that is, its degree of leakiness), and is lower for more tightly-constructed buildings. Modern, enclosed buildings with HVAC systems are generally more tightly constructed than residential buildings.

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